Claims

Claim 1. Apparatus that includes a tube in combination with an end-fitting, wherein:

[2] the tube has a tube-wall of thin flimsy flexible heat-shrinkable material;

[3] the end-fitting is of hard rigid material;

[4] the end-fitting has a protruding stem, over which the tube is attached;

[5] the stem is provided with a thread-form in the shape of a helical groove;

[6] the apparatus includes a helical coil spring;

[7] the spring is dimensionally related to the thickness of the tube-wall and to the groove such that:-

[8] - when an end-portion of the tube is in place on the stem, around the thread-form, the spring can be threaded along the thread-form, over the end-portion of the tube, without damage being caused to the tube-wall; and

[9] - when the spring is threaded over the end-portion of the tube, over the thread-form, the tube-wall lies pinched and compressed radially between the thread-form and the spring, the degree of compression being heavy enough to hold the tube in place against a substantial axial force, and to seal the tube to the stem, when the tube is inflated /deflated by a substantial pressure differential between the inside and the outside of the tube.

Claim 2. Apparatus of claim 1, being an apparatus that was constructed by the following procedure:-

[2] - placing the end-portion of the tube over the stem;

[3] - then heat-shrinking the end-portion down onto the stem;

[4] - then winding the spring along the tube, over the end-portion, pinching the end-portion between the spring and the stem.

Claim 3. Apparatus of claim 1, wherein:

[2] the apparatus comprises a bladder-pump for extracting a sample-volume of a liquid, such as water, from a borehole in the ground, and for conveying the sample-volume to the surface;

[3] and the tube of the apparatus comprises a bladder-tube of the bladder-pump.

Claim 4. Apparatus of claim 3, wherein:

[2] the bladder-pump includes an entry-port, which connects the interior of the bladder-tube to the liquid in the borehole;

[3] the bladder-pump has a lower-check-valve, so arranged in the entry-port between the

bladder-tube and the borehole that liquid communication therebetween is blocked when the pressure in the bladder-tube is greater than the pressure in the borehole;

[4] the apparatus includes a sample-transfer-pipe, which connects the interior of the bladder-tube to the surface;

[5] the bladder-pump includes an upper-check-valve, so arranged between the bladder-tube and the sample-transfer-pipe that liquid communication therebetween is blocked when the pressure in the bladder-tube is less than the pressure in the sample-transfer-pipe;

[6] the apparatus includes a pump-outer-tube, of a relatively robust character, which encircles the bladder-tube, creating an annular pump-space therebetween;

[7] the apparatus includes an operable pressure-controller, at the surface;

[8] the pressure-controller is effective, when operated, to manipulate the pressure in the pump-space such that the bladder-tube is alternately inflated and deflated, whereby liquid from the borehole is pumped to the surface.

Claim 5. Apparatus of claim 4, wherein the pump-outer-tube:-

[2] - has an internal diameter of less than fifteen mm, and preferably less than ten mm;

[3] - has substantial inherent rigidity;

[4] - is made of one of ptfe, polyethylene, or stainless steel;

[5] and wherein the bladder-tube:-

[6] - has a wall thickness of less than 0.2mm;

[7] - is so related dimensionally to the pump-outer-tube that the material of the bladder-tube is constrained by the pump-outer-tube and thereby prevented from stretching when pressurised;

[8] - is made of heat-shrinkable ptfe;

[9] and wherein the spring:-

[10] - has between four and ten coils;

[11] - is so dimensioned, in its unstressed condition, that the coils of the spring are increased in diameter by between 0.1mm and 0.5mm upon the spring being wound along the tube, over the end-portion, pinching the end-portion between the spring and the stem;

[12] and the profile of the groove in the stem, and the helical lead thereof, are such that the coils of the spring are held slightly apart upon the spring being wound along the tube, over the end-portion, pinching the end-portion between the spring and the stem.

Claim 6. Apparatus of claim 4, wherein the said end-fitting comprises an upper bladder-end-fitting;

[2] the said stem is formed on the upper bladder-end-fitting;

[3] the sample-transfer-pipe is physically coupled to the upper bladder-end-fitting, and is structured for sealingly conveying liquid from inside the bladder-tube up into the sample-transfer-pipe.

Claim 7. Apparatus of claim 4, wherein:

[2] the apparatus includes an adapter-piece, and includes a main-outer-tube of a relatively robust character, which is sealingly attached to an upper portion of the adapter-piece, and which extends to the surface;

[3] the said pump-outer-tube is sealingly attached to a lower portion of the adapter-piece;

[4] the bladder-tube lies inside the pump-outer-tube, an annular pump-space being present therebetween;

[5] the upper end-fitting of the bladder includes a long-tube, to which the sample-transfer-tube is in sealed fluid communication, and through which the sample from the borehole can pass into the sample-transfer-tube;

[6] the sample-transfer-tube lies inside the main-outer-tube, an annular upper-space being present therebetween;

[7] the adapter-piece has a hollow passageway inside, so arranged that the said upper-space is in fluid communication therethrough with the said pump-space;

[8] and the long-tube resides inside the hollow passageway in the adapter-piece.

Claim 8. Apparatus of claim 7, wherein the apparatus includes a mechanical connection between the adapter-piece and the long-tube, which is so structured as to limit vertical movement of the long-tube relative to the adapter-piece.

Claim 9. Apparatus of claim 8, wherein the mechanical connection is so structured as to permit a degree of up/down float, and rotation, of the long-tube relative to the adapter-piece.

Claim 10. Apparatus of claim 8, wherein the mechanical connection is so structured that the long-tube cannot move at all relative to the adapter-piece, neither up/down nor rotationally.